(12) UK Patent Application (19) GB (11) 2 201 745 (13) A

(43) Application published 7 Sep 1988

(21) Application No 8703987

(22) Date of filing 20 Feb 1987

(71) Applicant
Hydra-Tight Limited

(Incorporated in United Kingdom)

20 St Mary's Parsonage, Manchester, M3 2NL

(72) Inventor
Brian Virgo

(74) Agent and/or Address for Service
J A Crux R F Hadfield D D E Newman
PO Box 20, Ashburton Road West,
Trafford Park, Manchester, M17 1RA

(51) INT CL⁴
B25B 29/02

(52) Domestic classification (Edition J):
F2H 11A7 TA
U1S 1246 1269 2311 2316 F2H

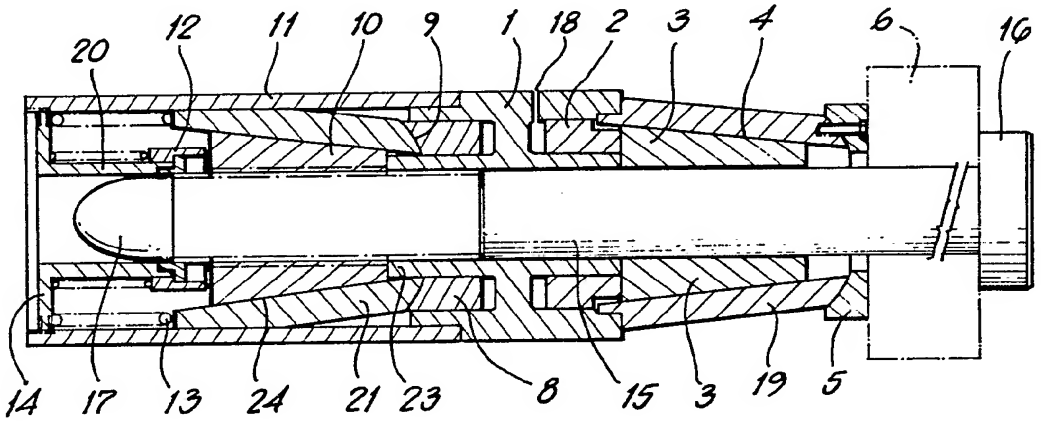
(56) Documents cited
GB A 2143608 GB A 2092254 GB 1543953
GB 1233974 US 4569258 US 4315446

(58) Field of search
F2H
Selected US specifications from IPC sub-class
B25B

# (54) Bolt tensioning apparatus

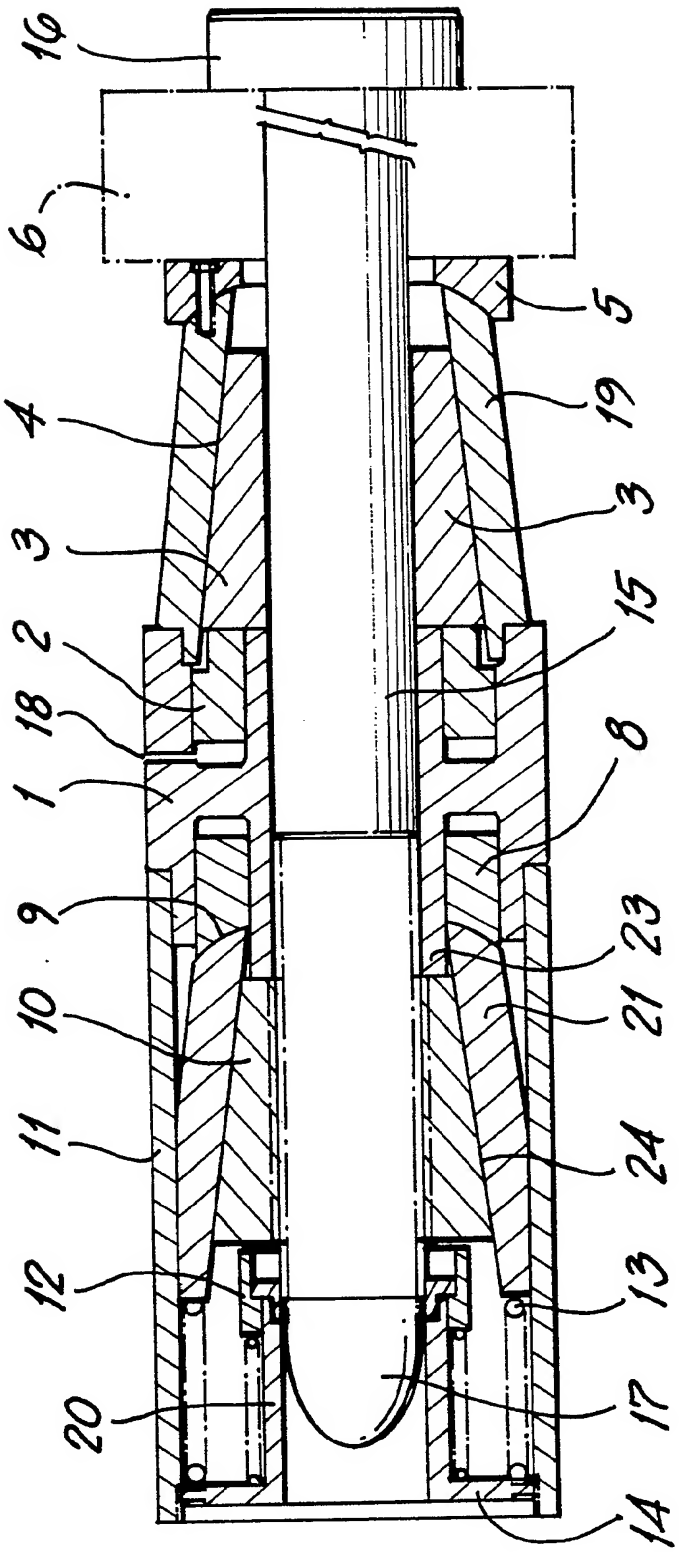
(57) A bolt tensioning apparatus comprises a body 1 mountable on and in encircling relation to the shank 15 of a bolt which is to be tensioned, the body 1 having a first piston-and-cylinder device 2 operable to displace axially of the body 1 a set of jaws 3 co-operating with conical cam surface 4 to cause the jaw members 3 to move radially inwards to grip the shank 15. A second piston-and-cylinder device 8 acts on a conical sleeve 21 housing a second set of jaws 10 which are forced radially inwardly against their spring.

In use, the bolt shank 15 is initially tensioned by the second set of jaws 10, then the first set of jaws 3 are forced inwards and the second set of jaws 10 released. The body 1, piston-and-cylinder devices 2,8, and the second set of jaws 10 may be removed, leaving the jaws 3, extension 19 and foot 5, to maintain the connection.




GB 2 201 745 A

The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.


16
6
5
19
4
3
3
15
2
18
8
1
9
23
21
10
24
11
12
13
20
17
14

Improved fastener systems

This invention relates to fasteners and in particular to bolted connections. It is known to use bolt stressing techniques to make up a bolted connection. Bolt tensioning tools using a hydraulic piston/cylinder device to stretch axially a bolt or stud (herein generally referred to as a bolt, for simplicity) prior to tightening a nut mounted on the screw-threaded shank of the bolt are well-known. GB-A-1590131 describes one such tool.

Conventional tools are perfectly satisfactory for most applications where human access is feasible in order to supervise installation, operation and then removal of the tool. However, there are occasions when remote installation and/or operation is desirable, as for example under water. There may be other applications where the integrity of the screw thread on the bolt shank is uncertain, possibly due to corrosion or other mechanical damage. It is an

object of this invention to provide an improved fastener system to meet such requirements, as well as being useful for more conventional tasks.

According to one aspect of the invention a fastener system comprises a body portion mountable on and in encircling relation to the shank of a bolt which is to be tensioned, the body having a first piston and cylinder device operable to displace axially of the body a set of jaw members, together with cam means progressively co-operating with said jaw members to cause said members to move radially inwards to grip the shank. This is the simplest embodiment of the invention; it may be used as a conventional bolt tensioner. The body could include a portion serving as a tensioner bridge surrounding a nut previously run down the bolt threads from its free end. This nut would then be accessible through at least one aperture in the bridge, thereby enabling the nut to be tightened down by hand after operation of the piston and cylinder device. It will be appreciated that in such a case, a conventional nut (or "puller") would be run down the bolt threads to hold the fastener system against the hardware associated with and from which the bolt extends. This puller would of course provide reaction means for transferring force from the piston and cylinder device into the bolt itself, to tension it.

However, it is particularly preferred that the puller comprises a second, oppositely directed piston and cylinder device, together with a second set of jaw members and second cam means whereby operation of said second piston and cylinder device will cause said second set of jaw members to grip the shank.

The first cam means may be constituted by an inner surface of an axial extension of the body; the extension may be provided with a distal abutment which in use, seats against hardware associated with the bolt to be tensioned. It will be appreciated that the hardware may be a flange or other coupling through which the bolt extends.

The second cam means is preferably contained within a second axial extension of the body, oppositely directed with reference to the first. In a particularly preferred embodiment, the second set of jaw members is positively located for minimal movement in an axial direction with respect to the body extension and the shank of the bolt, the extension being provided with internal stop means in the form of an abutment permitting only substantially radial movement of the jaw members. The second piston and cylinder device in this case acts directly on one end of a sleeve having an inner surface of conical section. The sleeve is preferably biassed towards the piston and cylinder device, for example by a spring, so that under conditions of non-operation, the jaw members are

free to move radially outwardly to clear the shank of the bolt. The sets of jaw members may also be provided with internal springs to promote such movement.

The shank of the bolt may be screw-threaded, ridged, or otherwise configured to enhance the gripping action of the sets of jaw members. It may also be plain. The free end of the shank, over which the tool is, in use, installed may be tapered to facilitate passage of the shank through the sets of jaw members, either or both of which may be biassed so as to hold the jaws open for such passage.

The body may be detachable from the first extension thereof, enabling removal of the body after use to leave only the first set of jaw members and the co-operating cam means (the first extension) in situ on the bolt shank.

In a further embodiment, the second set of jaw members, the associated cam means and axial extension of the body may be detachable, enabling that part of the tool to be removed together with the body, after use, the other part being left in situ, as mentioned above and as will be discussed later in more detail.

According to a further aspect of the invention a plurality of fastener systems are mounted on common support means, for substantially simultaneous installation and use on a plurality of bolts or

studs. The common support means may include remotely-operable means for effecting such installation. Where the plurality of fastener systems is to be installed and used on a flanged joint such as a pipe joint, the common support means preferably further includes means for urging the component parts of said joint together.The use of tapered distal ends on the bolts is particularly useful in this case for precise alignment of the confronting parts of the joint. For example, conventional hydraulic pulling tools may be used. In the case of underwater use, a remote operated vehicle (ROV) may be used to monitor and/or control the pulling together of the parts to be joined, installation of the fastener systems on their common support means, operation of the tensioners and (if appropriate) their subsequent removal along with any other re-usable hardware.

In order that the mode of use of the fastener system of this invention be better understood, it will now be described by way of example with reference to the accompanying drawing, in which the sole figure is a cross-sectioned side view. Referring to the figure, the apparatus comprises a body 1, having a first piston and cylinder device 2, and a second piston and cylinder device, 8. Hydraulic fluid to operate the devices is admitted and/or discharged through parts in the body 1; only one port is shown, at 18. The body has a first axial extension 19 provided with a foot 5, which in

use seats against the hardware against which the tool operates. In this case it is a flanged joint, part only of which is shown, at 6. The shank 15 of a bolt extends through the hardware, the bolt head 16 being on the side remote from the tensioner. The free or distal end of the bolt has a tapered end 17. The first piston and cylinder device 2 acts on a set of jaw members 3 whose radially-outermost surface engages a conical cam surface 4 defined by the inner surface of the first axial extension 19 of the body 1. Operation of the device 2 thus urges the jaw members 3 to the right (in the figure) and at the same time radially inwards against the bolt shank 15.

At the opposite end of the body there is a second axial extension 11, which is tubular and includes an end cap 14 retained in place by set screws (not shown). The cap 14 supports an internal sleeve 20, for reasons which will shortly be discussed. The second piston and cylinder device acts on one end of a conical sleeve 21, which slides inside the tubular extension 11. The mating ends of the piston and sleeve are radiused as indicated at 9 to accommodate possible misalignment of the bolt. Inside the conical sleeve, a second set of jaw members 10 are located axially with respect to the body 1 by abutment means 12 mounted to the internal sleeve 20. At the opposite end, the jaw members are located by an annular abutment 23 projecting from the body 1. Whilst thus located axially with respect to the body of the tensioner, the jaw members 10 have limited freedom to move radially

with respect to the bolt shank 15, depending on the disposition of the conical sleeve 21, the inner surface of which defines a cam surface 24, directly analagous to that (4) at the opposite end of the tensioner. A coil spring 13 is provided between the end cap 14 and the free end of the sleeve 21. The spring urges the latter to move to the right (in the figure), in the direction giving greatest freedom of radial movement to the jaw means 10. It will be appreciated that on operation of the second piston and cylinder device, the effect of the spring 13 will be overcome; the sleeve 21 will move to the left (in the figure) and the jaw members 10 will be forced radially inwardly against the shank 15.

In the interests of clarity, the operation of the fastener system just described will now be discussed in more detail. Firstly, the apparatus has to be mounted on the bolt shank 15 with the foot 5 against the hardware 6 (to provide adequate support for the apparatus to react against in use).

At this point both piston and cylinder devices are inactive; the respective pistons are free to retract into their cylinders and as a result the sets of jaw members are free to move apart to admit the bolt shank 15, the tapered end portion 17 serving to open the jaws, if need be. (Normally internal springs will be provided to facilitate this, as mentioned earlier.) Energising the second piston and cylinder device 8 will now cause the jaw members 10 to grip the shank of the bolt. The

reaction will naturally be transmitted through the body, the extension 19 and the foot 5 to the hardware 6. Once the jaw members 10 have engaged the shank 15 firmly enough, further increases of pressure in the piston and cylinder device 8 will cause the bolt to be progressively stretched. When a desired strain (corresponding to a desired or target stress in the bolt) has been achieved, the first pison and cylinder device 2 may be energised to force the first set of jaw members 3 against the bolt shank. Once they are firmly engaged with the shank, the pressure to the first piston and cylinder device 2 may be relieved. This must be done before relieving the pressure to the second piston and cylinder device, as otherwise the forces will tend to damage the apparatus. At this point, the locking action will normally be sufficient to enable the pressure on the second piston and cylinder device to be relieved, leaving the bolt shank in its stressed state.In practice, it should normally be possible to relieve both pressures at the same time. The body complete with the piston and cylinder devices and the second set of jaw members may then be pulled off the extension 19 for re-use, since the extension 19, the jaw members 3 and the foot 5 are all that is now needed. They serve the purpose which would normally be served by a conventional nut, but without the need for the conventional screw threaded connection.

It will be appreciated that provided the shank is at least in part screw threaded, a conventional

puller should be used in place of the second extension and related parts.

To release a connection made in this way it is necessary to re-install the rest of the fastener system (if it was removed). The piston and cylinder device 8 is then energised, to stretch the bolt and thereby retract/relieve the force on the jaw members 3 so that they are free to disengage from the shank 15. The jaw members 3 may be provided with spring means (discussed earlier but not shown) to assist in this. Alternatively, the piston and cylinder device 23 may be positively connectable to the jaw members so as to forcibly retract them. The use of a belleville spring washer to promote retraction is also possible.

It will be appreciated that the fastener system just described lends itself to remote operation, particularly in a remote or hostile environment such as sub-sea oil/gas installations. This is particularly true where a plurality of fastener systems are used together, as described earlier.

The invention further comprises a method of tensioning or stressing a bolt, stud or other cylindrical element, using the method just described with reference to and as illustrated by the accompanying drawing.

CLAIMS

1) A fastening system comprising a body portion mountable on and in encircling relation to a bolt or stud which is to be tensioned, the body having a first piston and cylinder device operable to displace axially of the body a set of jaw members, together with cam means progressively co-operating with said jaw members to cause said members to move radially inwards to grip the shank.

2) A fastening system according to claim 1 having a second oppositely directed piston and cylinder device, together with a second set of jaw members and second cam means whereby operation of said second piston and cylinder device will cause said second set of jaw members to grip the shank.

3) A fastening system according to claim 1 or 2 wherein the first cam means is constituted by an inner surface of an axial extension of the body.

4) A fastening system according to claim 3 wherein the extension is provided with a distal abutment which in use seats against hardware associated with the bolt to be tensioned and from which the bolt extends.

5) A fastening system according to any of claims 2, 3 or 4 wherein said second cam means is contained within a second axial extension of the body, oppositely directed with reference to the first.

6) A fastening system according to claim 5 wherein the second set of jaw members is positively located in an axial direction with respect to the second axial extension of the body by stop means provided within said extension, so that the second set of jaw members are constrained to move substantially radially with respect to the axis of the extension.

7) A fastening system according to claim 6 wherein the second piston and cylinder device acts on one end of a sleeve having an inner surface of conical section which constitutes said second cam means.

8) A fastening system according to claim 7 wherein said sleeve is biassed towards the piston and cylinder device so that under conditions of non-operation of the latter the jaw members are free to move radially outwardly to clear the shank of a bolt which, in use, passes between them.

9) A fastening system according to any preceding claim wherein the jaw members are adapted to grip a bolt shank of screw threaded, ridged or substantially plain surface.

10) A fastening system according to any preceding claim wherein spring means are provided to bias the set of jaw members radially outwardly, clear of gripping engagement with the shank of a bolt which in use passes therethrough.

11) Bolt tensioning apparatus comprising a plurality of fastener systems according to any preceding claim mounted on common support means for installation and subsequent use to tension a plurality of bolts substantially simultaneously.

12) Bolt tensioning apparatus according to claim 11 further comprising puller means operable to effect such installation.

13) Bolt tensioning apparatus according to claim 11 or claim 12 including puller means operable to bring together items of hardware to be secured by use of the plurality of fastener systems.

14) A fastening system according to claim 1 wherein the body complete with the first piston and cylinder device is detachably coupled to the first cam means and the associated jaw members, whereby only the latter need be left in situ after use to tension a bolt.

15) A fastening system according to any of claims 2 to 10 wherein the body, complete with both piston and cylinder devices and the second extension together with the second set of jaw members are detachably coupled to the first extension and its jaw members, whereby only said first extension and set of jaw members need be left in situ after use to tension a bolt.

16) A fastening system according to claim 1 or claim 15 wherein, after use, the first extension and set of jaw members constitute the sole retaining means for the tension developed in the bolt.

17) A method of tensioning a bolt or plurality of bolts substantially as hereinbefore described with reference to or as illustrated by the accompanying drawing.

Amendments to the claims
have been filed as follows



CLAIMS

1. A fastening system comprising a body portion mountable on and in encircling relation to a bolt or stud which is to be tensioned, the body having a first piston and cylinder device operable to displace axially of the body a set of jaw members, together with cam means progressively co-operating with said jaw members to cause said members to move radially inwards to grip the shank, together with a second oppositely directed piston and cylinder device, and a second set of jaw members and second cam means whereby operation of said second piston and cylinder device will cause said second set of jaw members to grip the shank.

2. A fastening system according to claim 1 wherein the first cam means is constituted by an inner surface of an axial extension of the body.

3. A fastening system according to claim 2 wherein the extension is provided with a distal abutment which in use seats against hardware associated with the bolt to be tensioned and from which the bolt extends.

4. A fastening system according to claim 2 or claim 3 wherein said second cam means is contained within a second axial extension of the body, oppositely directed with reference to the first.

5. A fastening system according to claim 4 wherein the second set of jaw members is positively located in an axial direction with respect to the second axial extension of the body by stop means provided within said extension, so that the second set of jaw members are constrained to move substantially radially with respect to the axis of the extension.

6. A fastening system according to claim 5 wherein the second piston and cylinder device acts on one end of a sleeve having an inner surface of conical section which constitutes said second cam means.

7. A fastening system according to claim 6 wherein said sleeve is biassed towards the piston and cylinder device so that under conditions of non-operation of the latter the jaw members are free to move radially outwardly to clear the shank of a bolt which, in use, passes between them.

8. A fastening system according to any preceding claim wherein the jaw members are adapted to grip a bolt shank of screw threaded, ridged or substantially plain surface.

9. A fastening system according to any preceding claim wherein spring means are provided to bias the set of jaw members radially outwardly, clear of gripping engagement with the shank of a bolt which in use passes therethrough.

10. Bolt tensioning apparatus comprising a plurality of fastener systems according to any preceding claim mounted on common support means for installation and subsequent use to tension a plurality of bolts substantially simultaneously.

11. Bolt tensioning apparatus according to claim 10 further comprising puller means operable to effect such installation.

12. Bolt tensioning apparatus according to claim 10 or claim 11 including puller means operable to bring together items of hardware to be secured by use of the plurality of fastener systems.

13. A fastening system according to claim 1 wherein the body complete with the first piston and cylinder device is detachably coupled to the first cam means and the associated jaw members, whereby only the latter need be left in situ after use to tension a bolt.

14. A fastening system according to any of claims 1 to 10 wherein the body, complete with both piston and cylinder devices and the second extension together with the second set of jaw members are detachably coupled to the first extension and its jaw members, whereby only said first extension and set of jaw members need be left in situ after use to tension a bolt.

15. A fastening system according to claim 1 or claim 15 wherein, after use, the first extension and set of jaw members constitute the sole retaining means for the tension developed in the bolt.

16. A fastening system substantially as herein described with reference to or as illustrated by the accompanying drawing..

17. A method of tensioning a bolt or plurality of bolts substantially as hereinbefore described with reference to or as illustrated by the accompanying drawing.

Published 1988 at The Patent Office, State House, 66/71 High Holborn, London WC1R 4TP. Further copies may be obtained from The Patent Office, Sales Branch, St Mary Cray, Orpington, Kent BR5 3RD. Printed by Multiplex techniques ltd, St Mary Cray, Kent. Con. 1/87.